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# MÖSSBAUER $Co^{57}$ SOURCE INCORPORATED INTO PALLADIUM

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ABSTRACT. The procedure for producing a Mössbauer $Co^{57}$ source incorporated in a palladium lattice is described. The electrolytic deposition of $Co^{57}$ onto palladium foil, as well as its introduction into the palladium matrix are described. The line width referred to zero thickness of the absorbent $Na_2[Fe(CN)_5NO] \cdot 2H_2O$ is increased by only 10% in comparison to the natural width. On the basis of the obtained Mössbauer spectra for various thicknesses of the absorbent the authors calculated a Debye - Waller factor for the source, which turned out to be equal to 0.8.

In the majority of cases, a Mössbauer source should radiate (unsplit) $\gamma$-line with a width as close as possible to the natural. Along with this the source must possess a large emission factor f without recoil (the Debye - Waller factor). Although the literature abounds in articles dealing with the Mössbauer isotope $Fe^{57}$, in not a single one of them is there given a complete, and at the same time simple and detailed technology of preparing a "good" source, which would make it possible for the experimental physicist to make it himself. The aim of the present article is to present a complete description of the method for preparing a Mössbauer $Co^{57}$ source which is incorporated into the palladium lattice [1]. /235*

If the source is to emit an unsplit $\gamma$-line without any line broadening at a large Debye - Waller factor, the matrix should have a lattice with a high Debye temperature, containing no atoms of Mössbauer isotope (in this case $Fe^{57}$) so as to avoid resonant self-absorption. At the same time it is desirable that a matrix, into which radioactive Mössbauer nuclei have been introduced, have a small value of z for decreased atomic absorption of soft $\gamma$-quanta. As the matrix we selected metallic palladium (a paramagnetic metal with a cubic lattice and a Debye temperature of $\theta = 275^{\circ}$ K). Palladium is the preferred material because it is easily rolled into thin foil. The latter readily heated by passage of current (during diffusion of the radioactive nuclei); is in addition, the thin foil limits the depth of the diffusion, and so does not impose rigorous conditions upon the mode of heating. Obviously, the smaller the depth of diffusion, the lower the atomic absorption in the matrix, and the "cleaner" the $\gamma$ pulse spectrum (Fig. 1); this, in turn, brings about an increase of the Mössbauer experimental effect.

*Numbers in the margin indicate pagination in the foreign text.

The source is prepared in the following manner. The parent isotope $Co^{57}$ ($T_{1/2}$ = 270 days) exists as the compound $Co^{57}Cl_2$. The $Co^{57}$ is deposited on a palladium foil 10 $\mu$ thick in the electrolytic bath shown in Fig. 2 [2, 3]. The palladium foil 5 in the form of a rectangular plate 20 x 5 $mm^2$ is pressed against a copper disk 6 by a teflon washer 4. The internal diameter of this washer, 3 mm, determines the dimensions of the active source. In turn, the washer is pressed down by a conical teflon cup 3, into which up to 1 $cm^3$ of electrolyte is poured. A platinum wire 1 mm in diameter is used as the anode 2. The electrolyte is obtained by adding concentrated ammonia to a hydrochloric-acid solution of $CoCl_2$ up to pH 11-12. During electrolysis the solution must be maintained alkaline in order to avoid redissolution of the deposited Co. The bath is supplied from a 6-V battery, the current being regulated by a rheostat. The current density is maintained at ~ 140 mA/$cm^2$. The solution is mixed by a vibrator 7, which is mechanically linked to the bath housing. The plexiglass bath support 1 is sufficiently flexible to permit vibration. Mixing of the

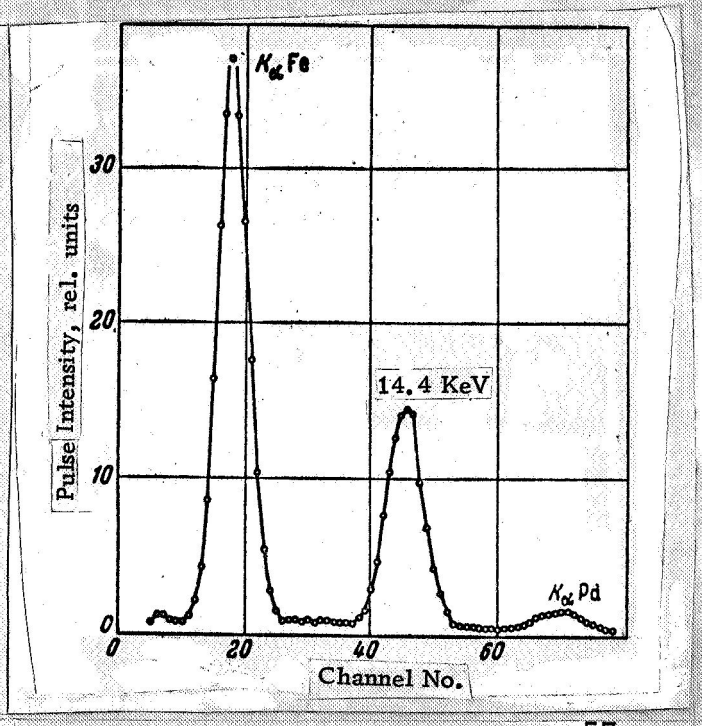


Figure 1. $\gamma$-Pulse Spectrum of $Co^{57}$ + Pd-Source, Obtained by Means of a Proportional Xenon Counter.

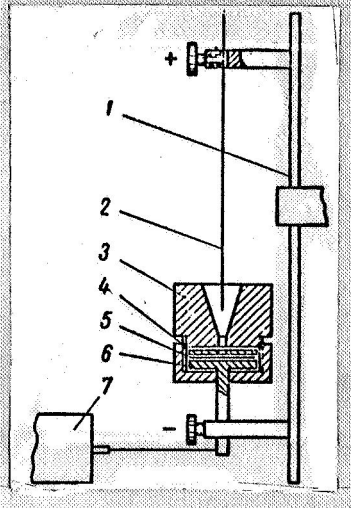


Figure 2. Electrolytic Bath.

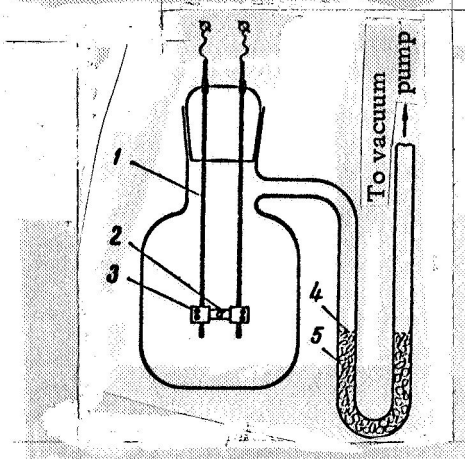


Figure 3. Part of the Vacuum Installation in Which the Diffusion is Effected: 1-Tungsten Wire, 2-Palladium Foil, 3-Brass Holder, 4-Copper Screen, 5-Nitrogen Trap with Activated Charcoal.

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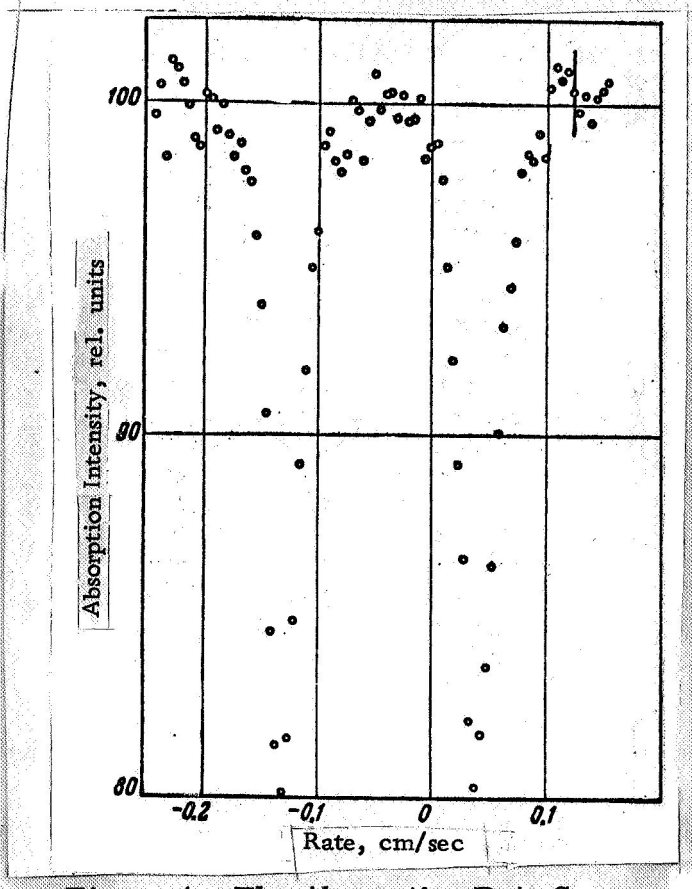


Figure 4. The Absorption Rate Spectrum in $Na_2[Fe(CN)_5NO] \cdot 2H_2O$.

solution, which provides for normal electrolysis, also helps in the elimination of gas bubbles which form, and sometimes interrupt the current. The electrolytic deposition of cobalt lasts from 2 to 3 hours, 80% of the activity being extracted. At the end of electrolysis the solution is sucked out of the bath by a pipette without interruption of the current, and the bath is rinsed out with distilled water.

The radioactive nuclei are introduced into the palladium matrix in vacuo ($10^{-3}$ torr), the foil being heated by electric current to 1100°C (Figure 3). The temperature is measured by an optical pyrometer. Heating takes appr. 2 min. After diffusion the foil must be cleaned with dilute hydrochloric acid, the surface being cleansed with a cotton wad, in order to remove the cobalt which has not diffused into the palladium. /237

The Mössbauer spectrum in $Na_2[Fe(CN)_5NO] \cdot 2H_2O$, shown in Figure 4, was obtained with a source obtained by the described method. The line width referred to zero thickness of the absorbent is increased by only 10% in comparison to the natural width; this may be explained by the considerable quantity of inactive cobalt, contained in the initial solution, and diffusing together with the $Co^{57}$. From the obtained Mössbauer spectra at varying thickness of the absorbent $Na_2 - Fe(CN)_5NO \cdot 2H_2O$ we calculated the Debye - Waller factor, which turned out to be equal to 0.8 [4, 5].

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Note in proofreading. An improved variant of the method has been published in Doklady Bolgarskoy Akademii Nauk (Reports of the Bulgarian Academy of Sciences), 1967, 20, 6, 537.

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